REMARKS/ARGUMENTS

A. Introduction

The present application is the national stage of international application No. PCT/IT/2003/000854 filed on June 24, 2003 and claiming priority to Italian application No. SV2002A000032 filed on July 9, 2002.

The marked-up copy of the specification and the amendments to the claims are based published application S/N WO-A 200400578 of January 15, 2004. Applicant has successively submitted a PCT Amendment on April 15, 2004, the contents of which are reflected in the present Preliminary Amendment.

While the international application was filed in the English language, certain terminology in the specification and in the claims does not conform to proper idiomatic English. Additionally, the structure of the claims does not conform to the applicable U.S. rules.

Therefore, corrections to the specification and claims have been introduced by means of this Preliminary Amendment, which is submitted pursuant to 37 CFR 1.115.

B. In the Specification

A substitute specification is submitted together with this preliminary amendment pursuant to 37 CFR 1.125 and MPEP 608.01(q). In particular:

1. No new matter has been added pursuant to 37 CFR 1.125(b);
2. A marked up version and a clean version of the substitute specification are enclosed pursuant to 37 CFR 1.125(c).

Regarding the changes to the original specification:

a. Paragraph numbering has been added;

b. Section titles have been added pursuant to MPEP 608.01(a);

c. Proper idiomatic English language has been introduced throughout;

d. Certain wording has been altered in order to maintain consistency of terms between written description and claims;

e. Certain wording has further been added in order to create an antecedent basis for the claims as in the original PCT application.

C. In the Claims

Claims 1-41 are pending in the present application. Therefore, upon entry of this preliminary amendment, claims 1-41 will be subject to examination.

As in the specification, proper idiomatic English usage has also been introduced in the claims. Additionally, the claims have been rewritten to comply with MPEP formatting requirements. For examples, proper usage of the articles "a" and "the" has been introduced; multiple dependencies in the additive and in the alternative have been eliminated; punctuation has been revised; consistency of terminology with the specification has been established where appropriate; and, in general, flow of language has been rearranged to conform with U.S. claim drafting format. No new matter has been added.

CONCLUSION

In view of the amendments and remarks submitted herein, Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

If it is felt for any reason that direct communication would serve to advance prosecution of the present application in this case, the Examiner is invited to contact the undersigned agent of record, Franco A. Serafini, by telephone, fax, or e-mail.

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Respectfully submitted,

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MARKED-UP COPY OF THE SPECIFICATION

TITLE OF THE INVENTION

[0001] Diaphragm valve and open/close element for said valve

STATEMENT REGARDING FEDERALLY SPONSORED REASEARCH AND DEVELOPMENT

[0002] Not applicable.

REFERENCE TO A COMPUTER LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX

[0003] Not applicable.

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0004] This invention ~~addresses~~ concerns a diaphragm valve, and, more particularly, a diaphragm valve having an inlet sleeve and an outlet sleeve of elongated cross-sections that converge into a valve seat of elongated shape controlled by a diaphragm of elongated shape. ~~which comprises a valve body, consisting of an inlet sleeve and an outlet sleeve, which have a curved shape and equal circular sections, and converge at least partly [[to]] a fluid flow chamber, which contains the valve seat, substantially consisting of the flattened and slightly concave surface of the line of intersection of the two sleeves on the opposed sides thereof, which chamber is divided into two parts with respect to a plane parallel to the plane tangent to the lower apex of the valve seat surface, one part whereof is integrated in the valve body, and is peripherally delimited by a clamping flange, and the other part consists of a bonnet to be sealably secured~~

~~onto said valve body, which bonnet has a coincident peripheral clamping flange[[,]] an elastic diaphragm being provided, made of rubber or the like, which has a peripheral sealing flange to be clamped between the peripheral flanges of said two parts of the chamber, said flange being connected to a central dome shaped convex part whose convexity is oriented, in an unstressed position, toward the valve seat[[,]] and means being provided on the concave side of the diaphragm, facing toward the bonnet, to compress the diaphragm against the valve seat surface in such a manner that, when the diaphragm is compressed against said surface, any fluid flow from the inlet sleeve to the outlet sleeve is prevented whereas, when the diaphragm is lifted and deformed toward the bonnet, free fluid flow is allowed.~~

2. DESCRIPTION OF RELATED ART

[0005] In ~~such~~ prior art diaphragm valves, ~~typically in the valve body, the sum of~~ the inlet and outlet sections of the valve body ~~are inscribable in a~~ converge into a substantially circular shape or [[in]] any such shape that is inscribable in a square, ~~as it is~~ such shape being generated by the confluence of two circular and substantially constant sleeves.

[0006] U.S. Patent 4,319,737 to Waterfield discloses a valve having inlet and outlet sections of elliptical shapes that combine into a circular shape, and further having an opening in the body closed with a flange of square-inscribable shape. ~~Therefore~~ In general, the diaphragms of the valves in the prior art are circular ~~in the concave part~~ and have square flanges. ~~For this reason, these~~ This causes such valves to have large sizes and considerable space requirements, particularly in the axial direction of flow. The manufacture of these valves also~~, and their fabrication~~ requires the use of a considerable amount of metal, resulting in very heavy weight and considerable costs, particularly as flow rates and inlet and outlet sleeve diameters, i.e. overall valve sizes, increase. Furthermore, particularly in hydraulically operated valves, the pressure exerted by the fluid that is piped in the pressure chamber ~~between~~ defined by the bonnet part and the valve closing dome of the diaphragm may cause the diaphragm to bow out, particularly into the outlet sleeve port, ~~wherein~~ because no counterbalancing pressure is provided, ~~and this causes~~ causing the so-called balloon effect. This drawback is also dependent on the considerable length of the radius of the circular diaphragm, when seen in the axial direction of the flow, and more particularly [[of]] on the long axial diameter of the outlet sleeve port opening into the flow

chamber, and is particularly serious in large-size valves, operating at very high flow rates and having ~~wide~~ large diaphragm surfaces. [[The]] This drawback may cause the unsupported diaphragm to be damaged, thereby leading to ~~seal defects~~ leaks and/or opening/closing problems, ~~due to the fact that~~ because the diaphragm is only partly resilient or is not resilient at all.

[0007] In order to obviate this drawback, a rib may be provided in an intermediate position of the outlet sleeve port opening into the flow chamber, which rib is oriented in the flow direction and is substantially perpendicular to the plane tangent to the lower apex of the valve seat. This rib has, at its edge facing toward the dome of the diaphragm, a flattened surface and is appropriately curved to prevent the dome from bowing out when the latter is compressed against the valve seat. Nevertheless, this rib causes an increase of the construction complexity of the valve, as well as [[its]] in the weight and cost of the valve, and does not solve the problem of the large size, in the flow direction, of prior art valves. Further ~~and~~, from the functional point of view, this rib leads to a possible build up of filamentary matters.

BRIEF SUMMARY OF THE INVENTION

[0008] ~~Therefore, this invention has the object of obviating~~ It is an object of the present invention to correct the above drawbacks, thereby providing, by using simple and inexpensive means, a valve as described hereinbefore, ~~whose~~ but with a diaphragm is not subjected to any abnormal deformation and consequent early wear and/or malfunctioning during use.

[0009] It is a further object of the present invention to provide a diaphragm valve having, ~~and has~~ an axial size, a weight and fabrication costs that are lower than in prior art valves.

[0010] The present invention achieves the above ~~purposes~~ objects by providing a valve ~~ad described hereinbefore, in which~~ having ~~the cross section of outlet and inlet sleeves, at the ends opening into the flow chamber, and at the~~ a valve seat, [[is]] flattened in the direction of flow, i.e. along the axis that joins the centers of the two inlet and outlet ends of the sleeves, ~~opening~~ Such inlet and outlet sleeves with flattened cross sections open into the flow chamber, and [[is]] are elongated in a direction transverse to the direction of flow, ~~particularly~~ preferably having a

substantially elliptic shape, or anyway a shape inscribable in a substantially rectangular peripheral clamping flange, [[and]] with the longer side disposed in a direction transverse to the direction of flow. Hence, the peripheral flange of the diaphragm may have a corresponding rectangular shape, inscribing the central convex portion of the diaphragm, which ~~consists of~~ comprises an element having the shape of a sector of an ellipsoid or a similar shape, wherein the ~~whose~~ section plane is disposed in such a manner as to ~~correspond~~ cooperate with the flow chamber port.

[0011] It shall be noted that the inventive concept defined as "flattened in the ~~flow~~ direction of flow" includes all diaphragm valves and all diaphragm--like open/close elements in which the ~~extension~~ length in the direction of flow, of the flow chamber, or of the flow chamber closing and diaphragm clamping flange, is shorter than the ~~extension~~ length in the direction transverse to the flow direction.

[0012] According to ~~a preferred~~ an embodiment of the invention, which will be described in greater detail ~~in the explanation of the drawings~~ below, from the respective free ends to the ends that open into the flow chamber, the two sleeves may have a cross section that progressively widens in a direction transverse and perpendicular to the flow direction and parallel to the separation plane between the two chamber parts, and progressively narrows in a direction substantially coincident with the bending radius of each sleeve so that the flow chamber port, at the flange of the chamber part integrated in the valve body, has a shape that is flattened in the flow direction and elongated in a direction transverse to said flow direction, and ~~particularly~~ preferably has a substantially elliptic shape, or anyway inscribable in a peripheral, substantially rectangular clamping flange, with the longer side disposed transverse to the flow direction. The peripheral flange of the diaphragm may have a corresponding rectangular shape. The ~~drastic~~ severe reduction of the axial size of the flow chamber port, which is obtained by using an elliptic shape, ~~allows to reduce~~ reduces the size and space requirements of the valve in the axial direction, which are generally more problematic than in the transverse direction. Furthermore, the use of a diaphragm having a dome with the shape of a sector of an ellipsoid prevents the latter from bowing out into the outlet sleeve port, thanks to the ~~small~~ reduced extension of the arc of said sector of ellipsoid, which corresponds to the ~~smaller~~ shorter diameter ~~of~~ along the section plane thereof and thanks to the ~~small~~ reduced axial size of said outlet sleeve port, which

is "narrower". The flow rate is maintained by correspondingly increasing the transverse size of the flow chamber port. By reducing the radius of the dome-shaped portion of the diaphragm in the direction of flow, the resiliency of the diaphragm is considerably enhanced, which in the idle, unstressed condition, i.e. when its convexity is oriented toward the valve seat. As is known, in the opened condition, the dome shape may be completely inverted, i.e. either more flattened or slightly bowed out toward the bonnet.

[0013] ~~According to an improvement~~ In a variation of this embodiment, the dome-shaped part of the diaphragm may have one or more stiffening ribs, to enhance the resiliency of the dome ~~from the condition in which it is deformed toward the bonnet to the normal unstressed condition, with the convexity being oriented toward the valve seat~~. These ribs may also have the function of preventing the dome from bowing out, when it is compressed against the valve seat. ~~Particularly~~ More particularly, stiffening and/or elastic or spring-like ribs may be provided on the concave side facing ~~toward~~ the bonnet of the diaphragm dome. An advantageous arrangement of the inventive ribs provides that a plurality of ribs are oriented in the flow direction or in the direction of the shorter axis of the diaphragm dome, a median rib being possibly provided in the direction transverse to the flow or along the longer axis of the diaphragm. The ribs improve resiliency over the whole geometry of the dome, but the shorter ~~rib~~ ribs, oriented in the flow direction, also contributes, in combination with a smaller extension of the port in the direction of the shorter axis, to further prevent the dome from bowing out into the outlet sleeve port.

[0014] Also, two more ribs may be provided on the concave side of the diaphragm dome, which faces toward the bonnet, to connect the center of the dome with the substantially median area of each of the four sections into which ~~the arcuate periphery of~~ the dome ~~base~~ is divided by the axis of the longer diameter and the axis or shorter diameter of the section plane of the sector of ellipsoid which forms the dome.

[0015] By ~~combining~~ a combination of the above arrangements, the additional advantage is obtained of avoiding the presence, as often provided in prior art valves, of an elastic dome preloading element, like a spring or the like, whose function ~~was~~ is to enhance the resiliency of the dome as it turns from the condition in which it is deformed toward the bonnet to the idle unstressed condition, i.e. with its convexity oriented toward the valve seat. This element is

generally provided between the bonnet and the concave surface of the diaphragm dome. An additional considerable advantage consists in that no intermediate axial wall is to be provided, ~~before~~ prior to the outlet sleeve port, for supporting the diaphragm dome in such a manner as to prevent it from bowing out, as mentioned above.~~, and this~~ This simplifies construction and provides savings on fabrication costs.

[0016] A rigid pressure element, or central stiffening member, ~~particularly~~ preferably having a circular shape, may be provided on the concave side of the diaphragm dome that faces toward the bonnet. This member may also ~~have the function to~~ protect the central portion of the dome, if a preloading member, such as a spring or the like, is eventually needed[[,]] to exert [[its]] a pressing action on the central area of the concave portion of the diaphragm. This need may arise in particularly heavy operating conditions of the valve.

[0017] According to ~~a preferred~~ one embodiment, which has a very simple construction, both the ribs and the central stiffening member may consist of ~~local~~ locally thickened portions of the diaphragm dome wall.

[0018] ~~In accordance with an additional improvement, the~~ The diaphragm dome may have a constant thickness, whereas at least some of the stiffening ribs, preferably all of them, have a thickness that increases toward the center of the dome so that the latter has an increasing ~~compliance toward~~ resistance to deformation towards the center, i.e. in the valve seat compressing area.

[0019] ~~Means~~ Retaining means may be further provided for holding the periphery of the diaphragm flange in such a manner as to prevent it from sliding along the plane of the clamping flanges of the bonnet and of the valve body, and from being extracted from between said clamping flanges. These retaining means may consist of one or more retaining teeth arranged along the peripheral edge of the diaphragm flange, which extend over the surface of the outer edge of the flanges of the valve body and/or the bonnet with a vertical orientation with respect to the plane of the flanges.

[0020] In accordance with ~~a preferred~~ embodiment, these retaining means may consist of two retaining tabs, each being provided along one of the longer sides of the diaphragm flange edge,

particularly in the intermediate area between two through holes into which pins are inserted to hold the flange of the bonnet against the flange of the valve body. Each of these holes may be provided in one of the four corners of the diaphragm flange. ~~These~~ Such retaining tabs extend over the corresponding surface of the outer edge of the valve body flange with a vertical orientation with respect to the plane of said flange and retain the diaphragm on the longer side thereof, ~~which can be~~ from where it may more easily ~~slid~~ slide out, due to the long distance between the two pins in the direction transverse to the flow.

[0021] These diaphragm ~~holding~~ retaining means may further ~~consist of~~ comprise one or more bosses provided on the clamping surface of the bonnet and/or the valve body which, with the two flanges in the coupled condition, compress the corresponding portion of the diaphragm flange thereby further preventing it from ~~being slid~~ sliding out.

[0022] ~~According to a preferred~~ In one embodiment of the invention, these retaining means may ~~consist of~~ include a continuous projection, ~~particularly~~ preferably having discontinuities in the areas adjacent to the pins, and ~~with~~ having a substantially elliptic profile[[,]] on the clamping surface of the bonnet flange which, ~~with~~ when said flange ~~being~~ is pressed against the valve body flange, extends along the substantially elliptic peripheral edge of the diaphragm dome and at a certain distance therefrom.

[0023] Means may be also provided for centering the bonnet with respect to the valve body and for laterally limiting any outward extension of the diaphragm flange, particularly while the dome portion changes from the condition in which its concavity is oriented toward the valve seat to the opposite condition, and vice versa.

[0024] These means for centering may ~~consist, for instance, of~~ comprise one or more retaining teeth arranged along the outer peripheral edge of the bonnet flange, which extend over the surface of the outer edge of the valve body flange with a vertical orientation with respect to the plane of the flanges.

[0025] Nevertheless, according to ~~a preferred~~ one embodiment of the invention, these means may consist of a tab that continuously extends along the whole peripheral edge of the bonnet

flange, which tab extends over the corresponding surface of the outer edge of the valve body flange, with a vertical orientation with respect to the plane of said flange.

[0026] The diaphragm flange may have, on at least one face, preferably on both faces, at least a continuous lip seal, ~~particularly~~ preferably having a substantially elliptic shape, which extends along the peripheral edge of the diaphragm dome and at a certain distance therefrom~~,~~ ~~which~~ and is compressed between the clamping flanges of the bonnet and the valve body, so as to enhance the peripheral sealing features of the diaphragm and to compensate for any variations in flange ~~fabrication tolerances~~.

[0027] A central rounded lip seal may be provided on the convex side of the diaphragm dome, facing toward the valve seat, when the dome is in the unstressed condition, which is disposed along the longer axis of the section plane of the sector of ellipsoid that forms the dome. When the dome is compressed against said surface of the valve seat, said lip acts as a compliant member~~, which helps~~ helping the dome ~~to adhere~~ in adhering against said valve seat ~~to prevent~~ and preventing any fluid flow from the inlet sleeve to the outlet sleeve.

[0028] The invention further relates to a diaphragm valve as described hereinbefore whose shape is particularly suitable to allow [[to]] the use of a plastic material in the manufacture of at least the valve body.

[0029] Further characteristics and improvements will ~~form the subject of the dependent claims~~ be detailed below.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0030] The characteristics of the invention and the advantages derived therefrom will be more apparent from the following detailed description of the annexed drawings, in which:

[0031] Fig. 1 is a side exploded view of ~~a preferred~~ a first embodiment of a valve according to this invention.

[0032] Fig. 2 is a top plan view of the valve body of Fig. 1.

[0033] Fig. 3 is a side elevational view [[on]] of the right half and an axial sectional view [[on]] of the left half[[,]] of the valve body of Fig. 1.

[0034] Fig. 4 is a ~~central~~ cross sectional view of the central portion of the valve body of Fig. 1.

[0035] Fig. 5 is a cross sectional view of the valve body as taken across ~~line D-D~~ plane F-F of ~~fig.~~ Fig. 2.

[0036] Fig. 6 is a top plan view of the diaphragm of the valve as shown in Fig. 1.

[0037] Fig. 7 is a sectional view, as taken along the shorter axis of the diaphragm of Fig. 6.

[0038] Fig. 8 is a sectional view, as taken along the longer axis of the diaphragm of Fig. 6.

[0039] Fig. 9 is a bottom plan view of the diaphragm of the valve as shown in Fig. 1.

[0040] Fig. 10 is a top plan view of the bonnet part of the valve as shown in Fig. 1.

[0041] Fig. 11 is a sectional view, as taken along the longer axis, of the bonnet part of Fig. 10.

[0042] Fig. 12 is a bottom plan view of the bonnet part of the valve as shown in Fig. 1.

[0043] Fig. 13 is a sectional view, as taken along the shorter axis of the bonnet of Fig. 10.

[0044] Fig. 14 is a perspective view of a diaphragm valve according to ~~another particular~~ a second embodiment of the valve, which is ~~specially~~ especially designed to be made out of plastic.

[0045] Figs. 15 to 18 are four views, of which two are side views, one is a top plan view and one is a bottom plan view, of the valve as shown in Fig. 14.

[0046] Fig. 19 is a section taken along ~~line~~ plane C-C in Fig. 15[[;]].

[0047] Fig. 20 is a section taken along line B-B in Fig. 15[[;]].

[0048] Fig. 21 is a cross sectional view of the valve as taken ~~across line~~ along plane A-A of ~~fig.~~ Fig. 18.

DETAILED DESCRIPTION OF THE INVENTION

[0049] Referring to [[the]] Figures 1-13, ~~the valve of the invention comprises~~ there is shown a first embodiment of the invention comprising a valve body 1, which is shown in a lower position, in Fig. 1, and an upper bell- shaped bonnet. The valve body 1 is composed of an inlet sleeve 3 and an outlet sleeve 4 which are each connected to an external port and have ~~a curved shape~~ an arched profile and are substantially identical, and converge by a confluence curve that opens into a fluid flow chamber which is upwardly delimited by an open/close diaphragm 5 and is peripherally limited by a body clamping flange 101 for pressing ~~the latter~~ diaphragm 5 against a corresponding peripheral bonnet clamping flange 102 of [[the]] a bonnet 2, ~~for securing the latter~~ in order to secure diaphragm 5 onto the valve body 1. The bonnet 2 and the valve body 1 are sealably fastened by means of bolts (not shown) passing through holes 202 and 201 which are formed each at one of the four corners of said two flanges 102, 101 and with the interposition of a peripheral sealing flange 105 of the diaphragm, which also has corresponding holes 205 for the passage of bolts. Each of the two sleeves 3, 4 has, at its respective free end, a substantially circular flange 103, 104 to be pressed against a corresponding flange which is provided along the peripheral edge of the end of a tubular valve fastening duct. It should be noted that, for the purposes hereof, the terms upper and lower will only be referred to the drawings, and that the valve may be obviously mounted in any other position. Similarly, the terms inlet sleeve 3 and outlet sleeve 4 shall be only intended as conventional designations, no predetermined flow direction being provided~~, as the valve body 1 is perfectly asymmetric~~.

[0050] The two sleeves 3, 4 have, starting from their respective free ends, a circular section which progressively widens in a direction transverse to the flow direction and progressively narrows in a direction substantially coincident with the radius of curvature, or bending radius, of each sleeve 3, 4, in such a manner that the flow chamber port, corresponding to the inner edge of

the flange 101, has a substantially elliptic shape, whereas the clamping flange 101 has a substantially rectangular peripheral shape, with the longer side disposed in a direction transverse to the flow direction. The line of intersection of the two sleeves 3, 4, on the opposed sides thereof, forms an intermediate wall 6 which extends transverse to the flow direction and whose flattened and slightly concave upper surface 106, whose concavity is oriented toward the diaphragm 5, forms the valve seat 106, i.e. the surface against which the diaphragm 5 is pressed to prevent any fluid flow therethrough.

[0051] The shape of the peripheral flange 105 of the diaphragm 5 substantially corresponds to that of the flange 101 of the valve body 1, and is correspondingly substantially rectangular, and inscribes a central convex part 305, whose convexity is oriented toward the valve seat 106, which is made of a cup- or dome-shaped member, and more particularly of a member having the shape of a sector of an ellipsoid, disposed with its section plane corresponding with the flow chamber port. The clamping flange 102 of the bonnet 2 has a rectangular shape which corresponds to that of the flange 105 of the diaphragm 5 and of the flange 101 of the valve body 1.

[0052] It shall be noted that the flow rate through the flow chamber is maintained even though the port thereof is narrowed in the flow direction, thanks to the fact that it is ~~equally~~ correspondingly widened in a direction transverse to said flow direction.

[0053] The valve of the invention has the same operation as prior art valves. When the dome 305 of the diaphragm 5 is compressed against the valve seat 106, any fluid flow is prevented from flowing from the inlet sleeve 3 to the outlet sleeve 4 whereas, when the dome 305 is lifted and deformed toward the bonnet, free flow is allowed. The valve that is shown in the Figures is hydraulically operated and the compression of the dome 305 against the valve seat is achieved in a well- known manner, e.g. by using a three-way valve, by supplying a pressurized fluid in the chamber delimited by the diaphragm 5 and the bonnet 2, through an inlet port 302 formed in the bonnet 2, whereas the valve is opened by discharging said pressurized fluid. The fluid to be used is preferably the same fluid that flows in the valve and is withdrawn therefrom through an intake 203 formed on the inlet sleeve 3. The outlet sleeve 4 itself has an intake 204 which allows to use the valve in both fluid flow directions. It should be noted that in the prior art, when the dome 305

is compressed against the valve seat 106, the dome- shaped part, which extends through the port of the outlet sleeve 4, with the pressurized fluid supplied between the diaphragm 5 and the bonnet 2 pressing against the concave surface thereof, tends to bulge or bow out into the outlet sleeve 4, as in this type of valves the outlet sleeve port ~~has a~~ is substantially semicircular and the dome has a corresponding relatively long radius of curvature in the axial flow direction, whereas in the inventive valve said radius is much shorter, ~~and prevents~~ preventing the diaphragm from bulging, or bowing out.

[0054] Moreover, the overall shape of the diaphragm 5, i.e. a sector of an ellipsoid, improves resiliency over the whole geometry of the dome, when it changes from the opening condition, in which it is deformed toward the bonnet 2, to the normal idle condition, in which its convexity is oriented toward the valve seat 106.

[0055] ~~Nevertheless, the~~ The guiding principle of this invention also advantageously applies to mechanically operated valves using an opening/closing wheel. The enhancement of resiliency of the dome 305 also advantageously ~~allows to avoid the presence of~~ does not require a preloading spring 7, which is typically provided in a central position between the bonnet 2 and the dome 305 and acts thereon by exerting pressure against the valve seat 106.

[0056] ~~bbbbb~~Nevertheless, whenever this is necessary, the spring 7 may be provided, in which case advantages result from interposing a compressor element, or convex pressure member 8 between the lower end of said spring and the dome 305, ~~whose convexity has~~ the convex pressure member having a convexity with the same orientation as the dome 305 when the latter is in the idle condition, which distributes the pressure of the spring 7 over a larger surface as compared with that of the end of the spring 7, and ~~protects~~ protecting the dome 305 from an excessive mechanical stress. It shall be further noted that, thanks to the elliptic port of the flow chamber, the valve has a very small longitudinal size as compared with prior art valves.

[0057] The dome 305 has a central stiffening rib 405 oriented along the longer axis, on the concave side facing toward the bonnet 2. Also, one or more transverse ribs 505 are provided perpendicular to said central rib 405 oriented along the longer axis, which ribs extend parallel to the shorter axis of the section plane of the sector of ellipsoid which forms the dome 305. One of

the ~~above~~ transverse ribs 505 extends along said shorter axis of the dome that is shaped like a sector of an ellipsoid. The individual transverse ribs 505 are evenly distributed along the extension of the rib 405 which coincides with the longer axis of the dome 305. Any number of transverse ribs may be provided, depending on the extension along the longer axis and/or the shorter axis of the dome 305, even one single transverse rib, for instance the central transverse rib, along the shorter axis of the dome 305.

[0058] A variant embodiment of dome 305 provides, besides the rib 405 oriented along the longer axis, another transverse rib oriented along the shorter axis and one or more ribs which branch off the center and are oriented in such a manner as to divide the four quadrants of the dome 305, which are defined by the longer axis and the shorter axis of the dome 305, into identical or different webs.

[0059] Both ~~variants provide~~ variant embodiments of dome 305 may comprise an additional central stiffening member 605, having a circular shape, which possibly protects against the pressure exerted by the spring 7 in the rare instances in which the latter has to be provided. The ribs 405, 505 further help to enhance the resiliency of the dome 305. Both the ribs 405, 505 and the central stiffening member are obtained by locally thickening the wall of the dome 305, the thickness of the ribs 405, 505 progressively increasing toward the center of the dome 305, and decreasing ~~substantially correspondingly to the profile of the wall of the dome 305 until they abut against the latter, at a certain distance from the upper edge for connection to the peripheral flat flange 105~~ toward the periphery of dome 305.

[0060] The sealing flange 105 may be provided with retaining means from preventing a sliding movement between body clamping flange 101 and bonnet retaining flange 102. As shown in Fig. 6, a [[A]] retaining tab 705 [[is]] may be provided along each longer side of the flange 105 of the diaphragm 5, in an intermediate position between the two through holes 205 for the coupling pins, which tab extends over the corresponding surface of the outer edge of the flange 101 of the valve body 1 and has a vertical orientation with respect to the plane of said flange 101, in such a manner as to ~~hold~~ secure the periphery of the flange 105 of the diaphragm 5 in position, and prevent it from sliding along the plane of the clamping flanges 102, 102 of the

bonnet 2 and the valve body 1 respectively, and from being extracted from between said coupled flanges 102, 101.

[0061] Furthermore, the flange 105 of the diaphragm 5 has a continuous sealing lip 805, 805' on both faces, which has a substantially elliptic shape and extends along the peripheral edge of the central portion of dome 305, at a certain distance therefrom, and is deformed by mutual compression of the two flanges 102, 101 of the bonnet 2 and the body 1 respectively. A central, rounded lip seal 905 is provided on the convex side of the dome 305 facing toward the valve seat 106, in a position corresponding to the ~~longer transverse~~ central rib 405 which, with the dome 305 compressed against said valve seat 106, acts as a compliant element and helps the dome 305 to adhere against said seat 106 and to prevent any fluid flow from the inlet sleeve 3 to the outlet sleeve 4.

[0062] A substantially elliptic projection 402 is provided on the clamping surface of the flange 102 of the bonnet 2, and ~~has~~ may have discontinuity areas in the proximity of the peripheral holes 202 ~~for the coupling pins which~~. When projection 402~~, when~~ is pressed against the flange 101 of the valve body 1, projection 402 extends along the peripheral edge of the dome 305, and compresses a corresponding portion of the flange 105 of the diaphragm 5, ~~while~~ further preventing it from being pulled out of position.

[0063] The peripheral edge of the flange 102 of the bonnet 2 has a continuous tab that extends over the corresponding surface of the outer edge of the flange 101 of the valve body 1, which has a vertical orientation with respect to the plane of said flange 101 and has the function of centering the bonnet 2 and of laterally limiting any outward extension of the flange 105 of the diaphragm 5.

[0064] The diaphragm valve in this embodiment of the invention has the considerable advantage of allowing the use of plastic [[for]] in the fabrication of the valve. In prior art, diaphragm valves are made of metal, particularly cast iron. In this case, the fabrication process requires the use of a disposable mold, whereby undercuts in the valve design cause no problem. The use of plastic in the fabrication of prior art problems involves instead two problems. First, in the conventional circular diaphragm version, valve sizes do not allow the use of plastic, due to

~~resistance problems~~ the limitations in mechanical strength of this material. Further, any structural change in the design of these valves for the purpose of ~~making~~ manufacturing them out of plastic~~, by using~~ and of adopting shape arrangements providing a stronger structure, would cause serious problems in terms of plastic valve sizes, as well as an increased mold complexity.

[0065] However, this embodiment of the invention ~~allows to conform the valve~~ provides for a valve configuration, particularly of the body thereof, ~~in such a manner as to allow~~ that allows it to be made out of plastic, without causing any ~~problem~~ problems regarding sizes and fabrication molds and ~~while further~~ ensuring the required ~~resistance~~ mechanical strength.

[0066] The smaller valve sizes provided by this embodiment of invention ~~allow to~~ enables the manufacture of the valve body in such a manner as to ~~ensure~~ meet small space requirements and to provide ~~the required~~ higher stiffness and mechanical strength.

[0067] Figures 14 to 20 show ~~the~~ a second embodiment of the ~~inventive valve~~ invention that is specially ~~designed to be~~ suited for a valve made of a plastic material. The inventive concept allowing ~~to reduce~~ the reduction of the diameter of the diaphragm and the related flange for clamping the latter between the valve body and the bonnet is substantially identical to that of the previous embodiment.

[0068] However, in plastic valves, instead of the two inlet and outlet sleeves 3, 4 which are curved and ~~widen~~ spread one toward the other, to form, in the intersecting portion, the arcuate surface that forms both the valve seat 106 and the flow chamber, and ~~whose~~ which have an aperture [[is]] flattened in the flow direction, particularly having an elliptic shape that corresponds to the elliptic dome 305 of the diaphragm open/close element 5, the two sleeves 3, 4 open into two pocket- like chambers 13, 14. The openings of the pocket-like chambers, whose axes are perpendicular to those of the inlet ends of the sleeves 3, 4 form, like in the valve of the ~~previous~~ first embodiment, a common aperture, defined by the edge of the fluid flow chamber that is flattened in the axial flow direction~~, and especially~~ (an elliptic aperture 206 is shown in Figure 14)~~, which is~~ and surrounded by the flange 101, inscribable in a rectangle, whereto the bonnet 2 may be sealably secured with the interposition of the peripheral flange 105 of the diaphragm open/close element 5. As shown in Figure 20, ~~The~~ the valve seat 106 ~~consists~~has, like

in the ~~previous~~ first embodiment, [[of]] an arched, saddle-shaped surface, formed by the two opposed walls transverse to the flow direction 113, 114 of the two pockets 13, 14 which end [[by]] with an upper edge, ~~inwardly~~ arched ~~with respect to~~ from the surface of the peripheral flange 101 towards the center of the valve, sloping down from both ends level with the peripheral flange 101 to the central area, with an arched and progressive profile, the edges of said two opposed transverse walls 113, 114 being connected by a flattened connection edge which forms the arched valve seat 106.

[0069] ~~It shall be noted that~~ As shown in Figures 14 and 18, the shape of the two pockets [[12]] 13, 14 substantially corresponds to half the peripheral edge 206 of the clamping flange 101.

[0070] The sleeves 3, 4 extend substantially perpendicular to the outer ~~wall~~ walls 213, 214 that ~~is~~ are parallel or substantially parallel to the opposed walls 113, 114 of the two pockets 13, 14.

[0071] The two opposed walls 113, 114 of the two pocket like chambers 13, 14 are substantially parallel and diverge at the closed bottom with arched or rounded walls 313, 314 toward the corresponding opposite outer wall 213, 214.

[0072] As is apparent, particularly from Figures 16, 17, 19, 20, 21, a number of transverse ribs 15 are provided between the two opposed walls 114, 113 of the two pocket-like chambers 13, 14, which ribs are oriented in the flow direction or along the shorter axis of the flattened or elliptic shape of the edge 206 of the flange 101. The ribs 15 extend in the hollow portion formed by the two facing walls 113, 114 and the outer side of the arched edge that forms the valve seat 106 and progressively widen as the relative distance between the two walls 113, 114 increases, until they end substantially flush with the bottom side of the two pocket-like chambers 13, 14. All, some or only two of the transverse ribs 15 may slightly project ~~out~~ outside of the bottom side of the pocket chambers 13, 14, thereby forming two support elements, or feet.

[0073] The bonnet 2, not shown in detail, is fabricated in the same manner as previously described with reference to Figures 1 to 13. The bonnet may be made of plastic or sheet metal,

~~particularly~~ preferably stainless steel ~~sheet~~, which is appropriately shaped by a drawing process. The diaphragm itself is unchanged with respect to that described ~~above~~ in the first embodiment.

[0074] One difference from the ~~previous~~ first embodiment, as shown in Figures 1 to 13, consists in that, in the second embodiment as shown in Figures 14 to 21, the flanges 101, 105 and 102 of the valve body, of the diaphragm 5 and of the bonnet respectively, have a greater number of through holes for bolt and nut pairs. This is ~~specially~~ especially necessary for large size valves, as both the sheet metal bonnet and the plastic bonnet that are provided in combination with the flange of the valve body, itself made of plastic, are relatively elastic and might not ensure the required sealing action, especially on the longer side, when only four fastening points are provided at the four corners of the two opposite shorter ends of said flanges.

[0075] It shall be noted, regarding the ~~previous~~ first embodiment, that no large-sized diaphragm valve is currently known to be made of plastic, the structure thereof being unuitable for this type of material. The novel ~~embodiment~~ design of the inventive diaphragm open/close element and, ~~consequently~~ correspondingly, of the valve body, ~~allows to obviate~~ obviates the technical problems associated with the manufacture of diaphragm valves of plastic.

[0076] ~~Obviously, the~~ The invention is not limited to the embodiment described and illustrated herein, but the ~~teaching~~ teachings of this invention [[is]] are applicable to a variety of valve types, ~~both~~ such as manually, mechanically, [[or]] hydraulically, or servo ~~operated~~ actuated, without departure from the guiding ~~principle~~ principles disclosed above and claimed below.

[0077] If the valve is mechanically operated, a compressor element may be provided on the side of the dome facing the bonnet, the compressor element having a pressing surface of a shape complementary to the bonnet and being rotatably linked to the inner end of a slidable control system passing through a hole formed in the bonnet. If the valve is hydraulically operated, a pressurized fluid (preferably the same fluid supplied to the inlet sleeve of the valve) is supplied into the space between the bonnet and the dome, in order to compress the dome against the valve seat. Likewise, the pressurized fluid may be discharged from such space, opening the valve.

[0078] Hence, for instance, the reduction of valve space requirements as provided by this invention in the flow direction ~~allows to obtain~~ enables an integrated valve-and-meter device in which, instead of providing a separate meter with means for sealably fitting it onto the inlet sleeve of the valve, the inlet sleeve of the valve is extended beyond the normal size and is integrated therein or forms itself the housing of a meter part.

[0079] Similarly, further operating units may be provided, integral with the valve. The particular reduced size construction of the inventive valve allows the construction of particularly compact integrated devices.

ABSTRACT

[0080] ~~The invention relates to a~~ A diaphragm valve (5)~~, which comprises~~ comprising a valve body (1)~~, composed of~~ having an inlet sleeve (3) and an outlet sleeve (4)~~, converging~~ that converge to a fluid flow chamber ~~which contains the~~ containing a valve seat (106)~~, formed by the flattened intersecting surface of the two sleeves (3, 4), which chamber is~~ and divided into two parts, one being ~~integrated in~~ integral with the valve body (1) and the other one consisting of a bonnet (2) ~~to be~~ sealably fitted onto the valve body (1). An ~~an~~ elastic diaphragm (5) ~~being~~ is provided~~, which has~~ having a peripheral flange (105) ~~to be clamped between two peripheral flanges (101, 102) of the two parts of the chamber, the latter being~~ connected to a central dome-shaped part (305), which~~, by using appropriate means situated between the dome (305) and the bonnet (2)~~ may be compressed against the valve seat (106), thereby preventing any fluid flow from the inlet sleeve (3) to the outlet sleeve (4). ~~According to the invention, the~~ The cross section of the two sleeves (3, 4)[[,]] near the valve seat (106)[[,]] is flattened in the direction of flow and elongated in the direction transverse thereto, ~~in such a manner as~~ so to form a substantially elliptical port, whereas the dome (305) of the diaphragm (5) has the shape of a sector of an ellipsoid~~, whose section plane corresponds to said flow chamber port~~.